for glass, the choice is restricted by the presumed necessity of avoiding appreciable double refraction. Common salt is singly refracting, but attempts to use it were not successful. Opaque patches always interfered. With the idea that these might be due to included mother liquor, the salt was heated to incipient redness, but with little advantage. Transparent rock-salt artificially broken may, however, be used with good effect, but there is some difficulty in preventing the approximately rectangular fragments from arranging themselves too closely.

The principle of evanescent refraction may also be applied to the spectroscope. Some twenty years ago an instrument had been constructed upon this plan. Twelve 90° prisms of Chance's "dense flint" were cemented in a row upon a strip of glass (Fig. 1), and the whole was immersed in a liquid mixture of bisulphide of carbon with a little benzole. The dispersive power of the liquid exceeds that of the solid, and the difference amounts to about three-quarters of the dispersive power of Chance's "extra dense flint." The resolving power of the latter glass is measured by the number of centimetres of available thickness, if we take the power required to resolve the D-lines as unity. The compound spectroscope had an available thickness of 12 inches or 30 cm., so that its theoretical resolving power (in the yellow region of the spectrum) would be about 22. With the aid of a reflector the prism could be used twice over, and then the resolving power is doubled.

One of the objections to a spectroscope depending upon bisulphide of carbon is the sensitiveness to temperature. In the ordinary arrangement of prisms the refracting edges are vertical. If, as often happens, the upper part of a fluid prism is warmer than the lower, the definition is ruined, one degree (Centigrade) of temperature making nine times as great a difference of refraction as a passage from D_1 to D_2. The objection is to a great extent obviated by so mounting the compound prism that the refracting edges are *horizontal*, which of course entails a horizontal slit. The disturbance due to a stratified temperature is then largely compensated by a change of focus.

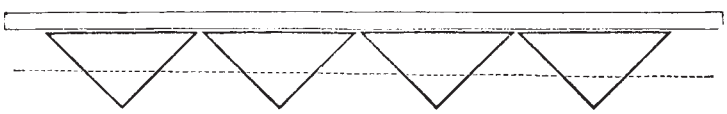

FIG. 1.

In the instrument above described the dispersive power is great—the D-lines are seen widely separated with the naked eye—but the aperture is inconveniently small ($\frac{1}{2}$-inch). In the new instrument exhibited, the prisms (supplied by Messrs. Watson) are larger, so that a line of ten prisms occupies 20 inches. Thus, while the resolving power is much greater, the dispersion is less than before.

In the course of the lecture the instrument was applied to show the duplicity of the reversed soda lines. The interval on the screen between the centres of the dark lines was about half an inch.

It is instructive to compare the action of the glass powder with that of the spectroscope. In the latter the disposition of the prisms is regular, and in passing from one edge of the beam to the other there is complete substitution of liquid for glass over the whole length. For one kind of light there is no relative retardation; and the resolving power depends upon the question of what change of wave-length is required in order that its relative retardation may be altered from zero to the quarter wave-length. All kinds of light for which the relative retardation is less than this remain mixed. In the case of the powder we have similar questions to consider. For one kind of light the medium is optically homogeneous, *i.e.* the retardation is the same along all rays. If we now suppose the quality of the light slightly varied, the retardation is no longer precisely the same along all rays; but if the variation from the mean falls short of the quarter wave-length it is without importance, and the medium still behaves practically as if it were homogeneous. The difference between the action of the powder and that of the regular prisms in the spectroscope depends upon this, that in the latter there is complete substitution of glass for liquid along the extreme rays, while in the former the paths of all the rays lie partly through glass and partly through liquid in nearly the same proportions. The difference of retardations along various rays is thus a question of a deviation from an average.

It is true that we may imagine a relative distribution of glass and liquid that would more nearly assimilate the two cases. If, for example, the glass consisted of equal spheres resting against one another in cubic order, some rays might pass entirely through glass and others entirely through liquid, and then the quarter wave-length of relative retardation would enter at the same total thickness in both cases. But such an arrangement would be highly unstable; and, if the spheres be packed in close order, the extreme relative retardation would be much less. The latter arrangement, for which exact results could readily be calculated, represents the glass powder more nearly than does the cubic order.

A simplified problem, in which the element of chance is retained, may be constructed by supposing the particles of glass replaced by thin parallel discs which are distributed entirely at random over a certain stratum. We may go further and imagine the discs limited to a particular plane. Each disc is supposed to exercise a minute retarding influence on the light which traverses it, and they are supposed to be so numerous that it is improbable that a ray can pass the plane without encountering a large number. A certain number (m) of encounters is more probable than any other, but if every ray encountered the same number of discs, the retardation would be uniform and lead to no disturbance.

It is a question of probabilities to determine the chance of a prescribed number of encounters, or of a prescribed deviation from the mean. In the notation of the integral calculus the chance of the deviation from m lying between $\pm r$ is (see *Phil. Mag.*, 1899, vol. xlvii. p. 251)

$$\frac{2}{\sqrt{\pi}}\int_0^{\tau} e^{-\tau^2}\, d\tau,$$

where $\tau = r/\sqrt{(2m)}$. This is equal to ·84 when $\tau = 1{\cdot}0$, or $r = \sqrt{(2m)}$; so that the chance is comparatively small of a deviation from m exceeding $\pm\sqrt{(2m)}$.

To represent the glass powder occupying a stratum of 2 cm. thick, we may perhaps suppose that $m = 72$. There would thus be a moderate chance of a difference of retardations equal to, say, one-fifth of the extreme difference corresponding to a substitution of glass for liquid throughout the whole thickness. The range of wave-lengths in the light regularly transmitted by the powder would thus be about five times the range of wave-lengths still unseparated in a spectroscope of equal (2 cm.) thickness. Of course, no calculation of this kind can give more than a rough idea of the action of the powder, whose disposition, though partly a matter of chance, is also influenced by mechanical considerations; but it appears, at any rate, that the character of the light regularly transmitted by the powder is such as may reasonably be explained.

As regards the size of the grains of glass, it will be seen that as great or a greater degree of purity may be obtained in a given thickness from coarse grains as from fine ones, but the light not regularly transmitted is dispersed through smaller angles. Here again the comparison with the regularly disposed prisms of an actual spectroscope is useful.

At the close of the lecture the failure of transparency which arises from the presence of particles small compared to the wave-length of light was discussed. The tints of the setting sun were illustrated by passing the light from the electric lamp through a liquid in which a precipitate of sulphur was slowly forming (*op. cit.*, 1881, vol. xii. p. 96). The lecturer gave reasons for his opinion that the blue of the sky is not wholly, or even principally, due to particles of foreign matter. The molecules of air themselves are competent to disperse a light not greatly inferior in brightness to that which we receive from the sky.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

OXFORD.—The honorary degree of M.A. was conferred in Convocation on Tuesday upon Mr. Roland Trimen, F.R.S.

Convocation has passed the decree accepting the offer of the Royal Geographical Society of 400*l.* for five years for the furtherance of geographical studies in Oxford, and providing an equal contribution from the funds of the University.

CAMBRIDGE.—The following is the speech delivered on May 11 by the Public Orator, Dr. Sandys, of St. John's

College, in presenting Prof. Kowalevsky, of St. Petersburg, for the honorary degree of Doctor in Science:—

Russorum ab imperio maximo legatus ad nos subito advectus est vir illustris, qui investigandi rationes novas inter primos secutus, animantium formas quasdam inferiores ex alia in aliam paullatim mutatas identidem indagavit; qui in confinio inter genera vertebris instructa et vertebris carentia iampridem moratus, Amphioxi speciem ambiguam primus explicavit; qui larvae denique Ascidianae cum vertebrato animalium genere affinitatem imprimis indicavit. Atqui, ne talium quidem virorum praeceptis attonitus, larvae illius degeneris propinquitatem reformidabit homo non terrestris tantum sed etiam caelestis originis conscius, qui angelis paullo minor, gloria et honore est coronatus, super oves et boves, super feras omnes, super volucres et pisces, super omnia quae maris per vias pererrant, a Deo constitutus.

Duco ad vos Zoologiae Professorem Petropolitanum, ALEXANDRUM KOWALEVSKY.

The General Board have issued a report recommending that the stipends of the Reader in Botany (Mr. F. Darwin), the Lecturer in Organic Chemistry (Mr. Ruhemann), the Lecturer in Experimental Psychology (Dr. Rivers), and the Curator in Zoology (Mr. D. Sharp), should be increased; and that new Lectureships in Palæozoology and in Physical Anthropology should be established.

A University Lectureship in Applied Mathematics will be vacant at Michaelmas by the resignation of Mr. Love, now Sedleian Professor at Oxford. Candidates are to send their names to the Vice-Chancellor by May 30. The stipend is 50*l.* a year.

The new Professorship of Agriculture, with a stipend of 800*l.* a year contributed by the Drapers' Company, was established by grace of the Senate on May 11.

THE Board of Education Bill was read for a third time, and passed, in the House of Lords on Monday.

THE foundation-stone of a new school and technical institute, connected with the Sir John Cass Foundation, in Jewry Street, Aldgate, was laid on Thursday last by the Bishop of London. The plans of Mr. A. W. Cooksey have been accepted for the new buildings, which will be in English Renaissance style, and will cost 45,000*l.*

MR. ANDREW CARNEGIE has written to the Right Hon. Joseph Chamberlain with reference to the proposed establishment of a University at Birmingham, and the correspondence is published in the *Birmingham Daily Post*. Mr. Carnegie refers in the correspondence to the great advantage which the iron and steel industries of the United States have derived from the Cornell University, and goes on to remark that "if Birmingham were to take that University as its model, where the scientific has won first place in the number of students, and give degrees in science as in classics, I should be delighted to contribute the last 50,000*l.* of the sum you have set out to raise to establish the scientific department." In addition to this Mr. Chamberlain, writing to the Lord Mayor of Birmingham, announces that an anonymous friend who had previously promised 25,000*l.* has agreed to increase his offer to 37,500*l.* on condition that the full amount of 250,000*l.* required for the *minimum* endowment is obtained. There still remains 12,000*l.* to be raised before the quarter of a million required is reached.

AT the annual celebration of Presentation Day of London University, held on May 10, the Earl of Kimberley presided for the first time as Chancellor. Referring to the Act passed last year, the Chancellor remarked that under the provisions of that Act and under the statutes made, the examination part of the University, by which the University had hitherto been known and in which it had done most excellent work, would be duly preserved. What was to be added was very important indeed, and it would become, he hoped, a great teaching University. They were at last beginning to appreciate the great changes which had taken place in the world, and in the advancement of science especially. Those changes had required others in the framing of the highest education. Not that they should for one moment abandon the old system of laying a good broad foundation of education, but that they should add to it the greater cultivation of the sciences, of economic science, and of all those arts which had grown to be of such great importance to this country. What they wanted was to bring together, as far as possible, all those various agencies provided for higher education in the metropolis.

INQUIRIES as to the schools in which leading men in various professions were educated have been made by *The School World*, and the results for men of science are published in the current number. Of 250 representative men of science—mostly Fellows of the Royal Society—chosen for the present inquiry, one-fifth received their early education either in private schools or at home under tutors. The schools which claim the greatest number of old pupils in the selected list are Edinburgh High School, Edinburgh Academy, and Aberdeen Grammar School. The Scotch schools are followed, as regards the number of old pupils of distinguished eminence in science, by the City of London School and King's College School. Eton, Harrow, and Rugby succeed these, and are in turn followed by Liverpool College, Royal Institution School (Liverpool), and St. Paul's. The remarkable point brought out by this comparison is the small part the great public schools have taken in training the leaders in science of the present day. When the men who are now in the foremost rank among philosophers were receiving their early education science was almost, if not quite, omitted from the public school curriculum, with the result that comparatively few boys from such schools have become eminent in the scientific world. The neglect of science in comparison with other subjects is shown by the fact that Eton, Harrow, Rugby, Winchester, Westminster, and one or two other public schools, though comparatively poor in their scientific record, are shown by *The School World* to have furnished the greatest number of leading men in Parliament, the Church, and the Law, Eton leading the way as regards numbers in each of these classes.

THE proposal to utilise the buildings of the Imperial Institute for the purposes of the new London University was referred to in the report read at the annual meeting of the Fellows of the Institute on Monday. Lord James of Hereford, who has succeeded the late Lord Herschell as chairman of the governing body, in moving the adoption of the report remarked that a new lease of life had been brought within the purview of the Institute. Those responsible for its management had been approached by the Government, who had to find accommodation for the London University. In the Institute they possessed a very great area of accommodation not needed by them, which could be devoted with very little adaptation for the purposes of the University. In the first place, to bring a great seat of learning under the roof of the Institute seemed to the governing body to be in accordance with the objects for which the Institute came into existence. But it was only right that he should tell them that in affording this accommodation to the London University they were receiving from the Government a very substantial return. He was not in the position to enter into any details, because all the arrangements had not yet been completed, but he might say that the negotiations were proceeding, and that by the financial return for the provision of the necessary accommodation for the University the governors of the Institute would be relieved of many burdens. The real result would be that they would have all anxiety removed with regard to the future conduct of the Institute.

SCIENTIFIC SERIALS.

Meteorologische Zeitschrift, February.—Results of the international balloon ascent, by Dr. H. Hergesell. This is the first of a proposed series of papers; the present one deals principally with the range of temperature, as shown by observations made in a captive balloon at Strassburg on June 7 and 8, 1898. The results prove that in strata of free air, whose height exceeds a few hundred metres, the temperature possesses an extremely small diurnal range. During the night it scarcely amounts to a few tenths of a degree; while in the daytime a variation of some three or four degrees Centigrade may occur, even at a height of 800 metres, when vertical air currents exist. In the absence of these, the range would, in all probability, sink to a very low value.—On the characteristics of mild winters, by Dr. G. Hellmann. The last two mild winters have induced the author to revise his previous researches upon this subject, and he gives particulars of the 51 mild winters experienced in Berlin during the last 180 years. The principal results arrived at are: that mild winters scarcely ever occur singly, but in groups of two or three; that they are usually of long duration, from November to February or March; severe and long, late winters (February and March) seldom occur after mild mid-